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## DETAILED DESCRIPTION

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[Detailed Description of the Invention]

[0001]

[Industrial Application]Concerning the coil for high frequency in more detail, this invention relates to the coil for high frequency of high Q used for a high-frequency oscillator, a high pass filter, etc.

[0002]

[Description of the Prior Art]Drawing 3 is a figure showing the conventional coil for high frequency.

Drawing 3 A is an exploded perspective view of the coil for high frequency, and drawing 3 B is a X-Y line direction sectional view of drawing 3 A.

1-1 to 1-3 shows the 1st layer - the 3rd layer (dielectric layer) of a multilayer substrate among a figure, 2-1 to 2-3 shows a coil pattern, and d shows the width of a coil pattern.

[0003]The coil was used for the former, for example, a high-frequency oscillator, and a high pass filter. As such a coil, the coil from which high Q is obtained is required. Then, the coil for high frequency as shown, for example in drawing 3 was considered. Drawing 3 is the example which constituted the helical coil using the multilayer substrate.

An exploded perspective view is shown in drawing 3 A, and the sectional view of a X-Y line direction is shown in drawing 3 B.

[0004]Like a graphic display, the coil pattern 2-1 is formed on 1-1st layer 1 of a multilayer substrate, the coil pattern 2-2 is formed on 1-2nd layer 2, and the coil pattern 2-3 is further formed on 1-3rd layer 3. And a graphic display dotted-line portion is connected by a blind through hole (through hole which filled the inside with the conductor).

[0005]If it does in this way, it will be connected in a graphic display dotted-line position, and the coil pattern 2-1, 2-2, and 2-3 will become a coil (helical coil) of high (three turns) Q rolled in the shape of helical one as a whole. In this case, the width d of each coil pattern 2-1 to 2-3 is set up so that all may become the same size.

[0006]Although the spiral type coil or moved-in a zigzag direction type coil which formed the spiral type or the moved-in a zigzag direction type coil pattern on the substrate out of the helical coil shown in drawing 3 is also considered, with these coils, the coil of high Q is not obtained compared with said helical coil.

[0007]That is, since an aforementioned spiral type coil or moved-in a zigzag direction type coil is not acquired [ an inductance value ] considering pattern length, if it is going to acquire the inductance value to need, pattern length will become long rather than a helical coil.

[0008]For this reason, a resisted part of a conductor increases and Q (it is the angular frequency of the frequency f at  $Q = \omega L/R$ , resistance of R:coil, and L:inductance  $\omega: \omega = 2\pi f$ ) of a coil becomes low. As mentioned above, as a coil from which high Q is obtained, a helical coil is required. This helical coil is constituted like the above (refer to drawing 3), and is usually patterned over more than two-layer.

[0009]For this reason, in a helical coil, it will have stray capacitance between the pattern at the upper part, and the pattern at the bottom. Therefore, when carrying out a circuit

design using a helical coil, it was designing beforehand in consideration of the aforementioned stray capacitance.

[0010]

[Problem(s) to be Solved by the Invention]The following technical problems occurred in the above conventional things.

(1) The helical coil is most suitable when you need the coil of high Q. However, when a helical coil is constituted from a coil pattern on the above substrates at the time of mass production, the stray capacitance between coil patterns is varied delicately by a printing gap of some of a coil pattern, and lamination gap of some of each sheet when carrying out laminate molding.

[0011](2) Especially, in a high frequency band (not less than 300 MHz), when the aforementioned coil is used for an oscillator or a filter, the variation in a capacity component turns into variation in the characteristic as it is, and appears.

[0012](3) If the impedance is measured with a high frequency band (not less than 300 MHz) when the coil by the above coil patterns is used as a chip inductor (air core), the variation in the capacity component between coil patterns will turn into measurement variation, and it will appear.

[0013](4) As mentioned above, when mass-producing a helical coil, the variation in the stray capacitance between coil patterns occurs. Thus, the self-resonant frequency of a coil of a capacity component is varied. In order to amend this, other electrodes needed to be adjusted delicately manually (for example, some electrode patterns are shaved). Therefore, time and effort was taken and it had also become a cause of the cost hike of a product.

[0014](5) Conventionally, in the spiral coil, even if the covering position of the pattern produced gap by both sides of the substrate, what suppressed the variation in stray capacitance as area total of areas of overlap did not change was known (refer to JP,62-123815,A).

[0015]However, this method is not what is related with the spiral coil patterned on the substrate (single plate), and was applied to the helical coil using a multilayer substrate. Although it was as having mentioned above that a helical coil is required to obtain the coil of high Q, there was no measure against the stray capacitance about such a helical coil conventionally.

[0016]An object of this invention when such a conventional technical problem is solved and a helical coil is constituted using a multilayer substrate, even if a printing gap of a coil pattern, a lamination gap, etc. occur is to be able to be made to perform stabilization of the stray capacitance between coil patterns.

[0017]

[Means for Solving the Problem]Drawing 1 is a principle figure of this invention, drawing 1 A is an exploded perspective view of a coil for high frequency, and drawing 1 B is a X-Y line direction sectional view of drawing 1 A. Drawing 3 and a same sign show the same thing among a figure.  $d_1$  and  $d_2$  show width of a coil pattern. A coil for high frequency of this invention was constituted as follows, in order to solve the above-mentioned technical problem.

[0018]Namely, two or more coil patterns 2-1 provided, respectively on two or more dielectric layers 1-1 which constitute a multilayer substrate, and 1-2, and 2-2 are connected, The coil pattern 2-1 on a dielectric layer which is the coil for high frequency

used as a helical coil, and adjoins each other, width  $d_1$  of 2-2, and  $d_2$  were changed ( $d_1 < d_2$ ).

[0019]

[Function]The operation of this invention based on the above-mentioned composition is explained referring to drawing 1. On the 1-1st layer (dielectric layer) 1 which constitutes a multilayer substrate, form the coil pattern 2-1 of a thick film conductor, and the coil pattern 2-2 of a thick film conductor is formed on 1-2nd layer (dielectric layer) 2. By connecting a graphic display dotted-line portion in a blind through hole (through hole where the inside was filled with the conductor), it is considered as the coil (spiral coil) of spiral shape.

[0020]In this case, the coil pattern 2-1 forms pattern width as  $d_1$ , and the coil pattern 2-2 forms pattern width as  $d_2$ , and it forms said both coil patterns in the position which counters in a laminating direction. It sets up so that said pattern width  $d_1$  may differ from  $d_2$  ( $d_1 < d_2$ ).

[0021]If it does in this way, even if a printing gap and a lamination gap occur at the time of the coil pattern 2-1 and formation of 2-2, it can be set as the position which two coil patterns always counter in a laminating direction.

[0022]Therefore, at the time of the mass production of the coil for high frequency, the variation in the stray capacitance between coil patterns decreases, and variation in the self-resonant frequency of a coil can also be lessened. Manual fine adjustment also becomes unnecessary.

[0023]

[Example]Hereafter, the example of this invention is described based on a drawing.

Drawing 2 is a figure showing the example of this invention.

Drawing 2 A is an exploded perspective view of the coil for high frequency, and drawing 2 B is a X-Y line direction sectional view of drawing 2 A.

Drawing 1, drawing 3, and a same sign show the same thing among a figure.

[0024]This example is an example which constituted the helical coil (coil for high frequency) of 3 turns using the multilayer substrate.

The exploded perspective view is shown in drawing 2 A, and the X-Y line direction sectional view of drawing 2 A is shown in drawing 2 B.

[0025]Like a graphic display, the coil pattern 2-1 is formed on the arbitrary 1-1st layer 1 of a multilayer substrate, the coil pattern 2-2 is formed on 1-2nd layer 2, and the coil pattern 2-3 is further formed on 1-3rd layer 3 (each coil pattern is formed in the position which counters in a laminating direction).

[0026]Said each coil pattern 2-1 to 2-3 is formed as a thick film conductor pattern (printing pattern) of 1 turn, respectively, It connects by a blind through hole (through hole where the inside was filled with the conductor), and a graphic display dotted-line portion is used as the helical coil (helical coil) of 3 turns as a whole.

[0027]And when forming said each coil pattern 2-1 to 2-3, it sets up like a graphic display of the width of this coil pattern. In this example, coil width of  $d_2$  and the coil pattern 2-3 is made [ the coil width of the coil pattern 2-1 ] into  $d_1$  for the coil width of  $d_1$  and the coil pattern 2-2.

[0028]In this case, the width of each coil pattern is set up become a relation of  $d_1 < d_2$ . That is, width  $d_2$  of the coil pattern 2-2 on 1-2nd layer 2 is made larger than width  $d_1$  of

the coil pattern 2-1 on 1-1st layer 1. Width  $d_1$  of the coil pattern 2-3 on 1-3rd layer 3 is made narrower than width  $d_2$  of the coil pattern 2-2 on 1-2nd layer 2.

[0029] Thus, between two coil patterns which counter in a laminating direction, if the width of the coil pattern is changed alternately, even if a printing gap of some and a lamination gap occur, it can set up so that the area which always counters may become fixed. Stray capacitance can be stabilized and the self-resonant frequency of a coil also stops for this reason, shifting.

[0030] (Other examples) Although the example was described above, even if it performs this invention as follows, it is feasible.

(1) The coil for high frequency of this invention (helical coil) mounts other parts in the same multilayer substrate, and is good for it also as a high-frequency oscillator or a high pass filter (module).

[0031] (2) The high frequency coil (helical coil) of this invention may be constituted as a coil chip.

(3) Although two turns and three turns may be sufficient as the number of turns of a helical coil, more than it may be sufficient.

[0032] (4) In the example of drawing 2, although the same width ( $d_1$ ) may be sufficient as the width of the coil pattern 2-1, and the width of the coil pattern 2-3, they may be set as different width. For example, width of  $d_2$  and the coil pattern 2-3 may be made into  $d_3$  for the width of  $d_1$  and the coil pattern 2-2, and the width of the coil pattern 2-1 may be set up like  $d_1 < d_2 < d_3$  or  $d_3 < d_1 < d_2$ . However, the pattern width setting out of the direction which does not counter each other directly as much as possible of the coil pattern 2-1 and the coil pattern 2-3 is more preferred.

[0033]

[Effect of the Invention] As explained above, according to this invention, there are the following effects.

(1) Since the width of the coil pattern which counters in a laminating direction differs even if a printing gap of a coil pattern, a lamination gap, etc. occur, the opposing area of this coil pattern can be kept constant.

[0034] Therefore, the stray capacitance ingredient generated between each coil pattern changes and is stable.

(2) Since a stray capacitance ingredient is stable, even when a helical coil is mass-produced, the variation in self-resonant frequency decreases.

[0035] (3) Since stray capacitance is stable, fine adjustment by handicraft like before becomes unnecessary. Therefore, time and effort can be saved and the cost cut of a product is also attained.

(4) Since the variation in the stray capacitance ingredient of a coil decreases, gap of the characteristic can be suppressed when the helical coil of this invention is used for an oscillator or a filter.

[0036] (5) Since the variation in the stray capacitance ingredient of a coil decreases, when the helical coil of this invention is used as an air-core coil chip, it becomes parts with little variation in impedance with a high frequency band.